

Preface: Impact Hazard, a Russian Roulette

Science is never ending, and the more we learn, the more we see how much we ignore. Descartes said that he would give everything he knew, if he would get half of what he ignored. What a good business for him, who died when Newton was still eight!

After three centuries of riding the knowledge wave created by the latter, and now the new one by Einstein, even we would be quite well off if we made that swap.

Let's take the planets outside our Solar system as an example: until 2009, using various means, we discovered about 50 per year. That year, the specialized space telescope Kepler was launched, and speed was multiplied threefold. Now, reviewing the database of its measurements till 2013 (when it malfunctioned) and using some degraded modes of operation, around 1000 are added per year. However, Kepler has only studied about 4 % of the sky. Making simple calculations about the number of stars in that area and the number of planets found, we can be sure that most stars do have them: there must be millions, and not too far, still unknown! ESA's PLATO mission will study a million stars over the whole sky. Let's see.

Now we even observe planetary systems in formation, and just the leftover bodies of planetary formation are the asteroid and comets currently forming part of our planetary system. These so-called minor bodies are very relevant because they allow us to date the origin of our solar system and the processes that sculpted planets. Because of their importance, a number of missions of exploration have been dedicated to study these bodies recently. There are literally millions, and we keep discovering lots of them every day. Until 1990, we knew about 15,000 objects. In 2000 they were already 125,000, and we are already at 700,000. A NASA program managed to catalog virtually all the very large ones over 1 km, of which at the end of April, 2016, we know about 875. On February 15, 2013, an object just 20 m in size caused destruction in Chelyabinsk, in Siberia, and the world woke up concerning this risk. Would one of those fall on us? Last year a comprehensive study demonstrated that there are 10 million such objects close enough to Earth, and very few are actually known. As if the growing number of near-Earth asteroids wasn't enough, there is also a population of extinct comets, with highly eccentric and much higher impact power, that are extremely dark and difficult to detect. An

example was the object, 600 m in diameter, called Great Pumpkin (officially 2015 TB145), which approached to only 480,000 km of Earth for Halloween 2015. This extinct comet was discovered with only 3 weeks of margin, exemplifying the need of multiplying the resources dedicated to detecting these dangerous objects that result from the aging and final disruption of periodic comets.

Data revealed in 2013 from the military infrared observatories confirms exactly the numbers about the flux of these objects, and we have even recent evidence that the flux of Chelyabinsk-size projectiles (few tens of meters) could be higher than we thought. We need to take action. It is imperative to give a large impulse to specialized space telescope missions like the Sentinel of the B612 Foundation, in order to find these million objects and have early warning. And in parallel we need to work on deflection techniques like the Don Quijote project. Time to take action in front of a threat of this caliber might be certainly more valuable than gold.

However, space agencies have not yet decided to assign the necessary resources to those missions, although we may be getting close. The new version of Don Quijote, called AIDA, a joint NASA/ESA project, is still in study phase on both sides. NEOCam, a NASA proposal, is also awaiting funding. In this framework, the international outreach initiative called Asteroid Day is a magnificent way to inform the public about our serious concern. In such framework the international workshop “Assessing the nature of asteroid impact hazard to transform it into technological opportunity” was an initiative of the Institute of Space Sciences (CSIC-IEEC), supported by the Academia Europaea, Parc de Recerca UAB (PRUAB), Asteroid Day, Elecnor-Deimos y SENER.

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Finally we would like to remark that the Association of Space Explorers, the world’s astronauts, is promoting within our own Agencies, with the public, and with

the United Nations, the idea that it is time to take action and move from concept to development. This year 2016 both NASA and ESA are due to take decisions about their future programs, and we promote and hope that both Agencies realize that the returns of such missions may be enormous and that it is time to stop playing *Russian Roulette* in the hostile environment through which our common spaceship Earth moves day in and day out.

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